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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Bakery Machinery Lubrication

The Viscosity Test

Its Meaning and Application

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

Effective Lubrication

and

The Mechanism of Baking

Purity of products in the baking industry depends to a marked extent upon the manner of lubrication and the grades of lubricants employed. The use of oils or greases that are inferior or unsuited to the construction of the machinery, may frequently cause the ruination of otherwise perfect foodstuffs, due to contamination. This possibility will be increased where lubricants are applied in a careless or sloppy manner. For this reason lubrication of baking machinery requires most careful study, to obtain the utmost satisfaction from the lubricants used.

Those who have to deal with the operation and maintenance of baking machinery should have a thorough knowledge of the working parts, the means provided for lubrication and the grades of lubricants best suited to their protection. In the interest of consolidating such information the accompanying article has been prepared.

THE TEXAS COMPANY.

LUBRICATION

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Bakery Machinery Lubrication

EFFICIENT operation of baking machinery and the manufacture of quality products depends to a marked degree upon the manner of lubrication and the grades of lubricants used. It is most important to prevent contamination of materials by lubricants. Manufacturers of the machinery employed have fully realized this essential, with the result that the most highly perfected methods of automatic lubrication are found in the modern bakery. The machinery of baking is comparatively high speed. Some units are subject to a certain amount of dust, and in the operation of travelling oven mechanisms lubricants must be chosen from the viewpoint of their heat resisting ability. To enable thorough understanding of the individual lubricating problems, study of the various operations, step by step, is advisable.

Sifting and Bolting

Baking operations begin with handling of the flour. Sifting and bolting is necessary after it is received in the bakery, even though it may have been subjected to these operations in the mill, for all impurities or lint which it may have gathered during handling or transit must be removed. For this purpose a cone sifter or bolting reel is used. Blending and aerating is also carried out in this operation. Sifting or bolting effectively breaks up any lumps or compact masses which may have formed in the sacks. This entire treatment serves to bring about subsequent formation of a smooth, high grade dough.

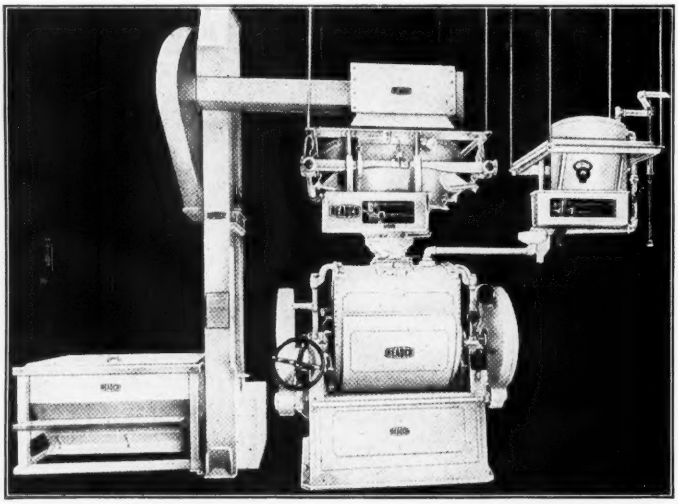
The Mixer

Mixing is the first direct step in the preparation of the dough. Flour and other necessary ingredients of the dough, such as water, milk, yeast, salt, malt and shortening may be added directly to the mixer in measured quantities or mixed before-hand in a so-called ingredient mixer. This auxiliary is becoming popular in modern practice because the thorough preliminary mixing of these substances tends to a more uniform loaf of better texture. In addition, labor and time for mixing is materially reduced. Such a mixer is also used to advantage in dissolving yeast in water, mixing other yeast foods, pastry and sweet goods.

Production demands have necessitated considerable study of speed in mixing operations until today relatively high speeds, around 60 r.p.m., have superseded almost entirely the old custom of rotating the mixer arms at but a few r.p.m. At such speeds mixing is more thorough, the gluten is better developed, and the texture, color and absorption are materially improved. Inasmuch as the fermentation period is also decreased by the use of a high speed machine, more of the desirable ingredients are retained and slacking is prevented.

Due to the texture of the dough, abnormal temperatures may develop as the speed of the mixer is increased, unless steps are taken to counteract this; modern procedure is, therefore, to blow a steady current of cold, dry air into the mixture through the mixing arms. This air should be suitably filtered and washed to absolute purity, it being delivered by motor

driven blowers at about 80 degrees Fahr., through sealed ducts. This process of air cooling presents other advantages for the oxygen bleaches the dough and yeast action is acceler-



Courtesy of Read Machinery Co., Inc.
Fig. 1—Showing Readco 2-C Sifting and Mixing Outfit. This is a one-floor installation consisting of a dump bin, elevator, head conveyor, cone sifter, weighing hopper and measuring tank.

ated. The time required for mixing will vary from 8 to 15 minutes, depending on the type of machine used, and the grade of the flour. Naturally the lower the mixing period the greater will be the efficiency and rate of production; also, the lower will be the power consumption per batch.

Mixers differ in construction, chiefly in the arrangement of the arms, the driving mechanism and method of tilting. Modern practice dictates that:

The dough should be rolled, pulled and stretched by the arms so as to develop the gluten to the greatest extent, with no cutting or tearing.

There should be no joints or bearings to come in contact with the dough, and the axle bearings should be entirely separate from trough ends.

Mixing arms should be designed (using hollow centers as some manufacturers advise) so that the dough will not wad thereupon, but fall through easily.

The machine should be self-cleaning and no dry or unmixed ingredients should be able to collect on the back of the mixing blades.

All driving and operating gearings, chains, etc., should be enclosed.

The edge of the blades should act as a knife to keep the bowl scraped clean, and

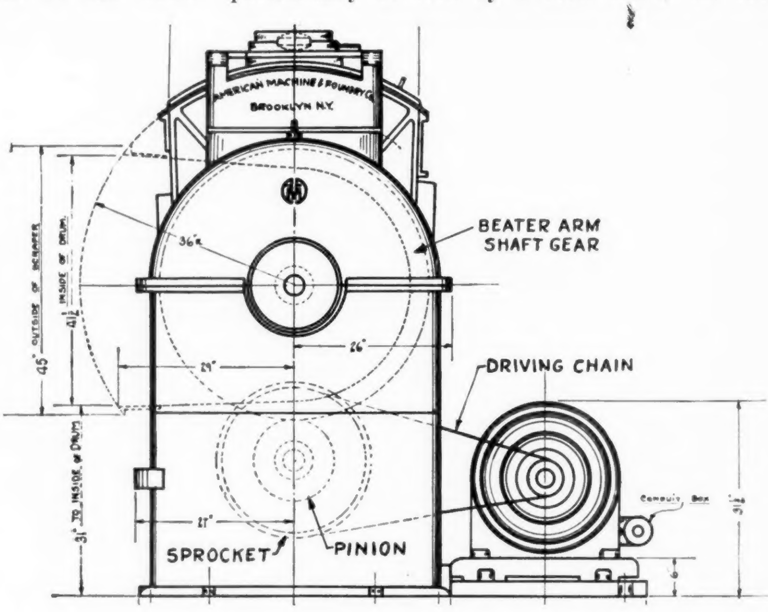
The frame should be rigid, so that no vibration occurs, thus insuring smooth operation.

Dividers

After the dough has been mixed it is removed from the mixer and delivered in bulk, usually by gravity via a chute to the feed hopper of the divider. This machine divides the dough, scaling it to loaves of any desired size and weight without variation. The divider was developed to supplant the old method of scaling loaves by hand, which was slow, unsatisfactory and often conducive to considerable loss due to overweight.

Mechanical dividing overcomes all these objections.

The constructional principles of the modern divider are unique. In one type of machine the dough, as fed from the hopper, is periodically severed by a steel knife, the cut

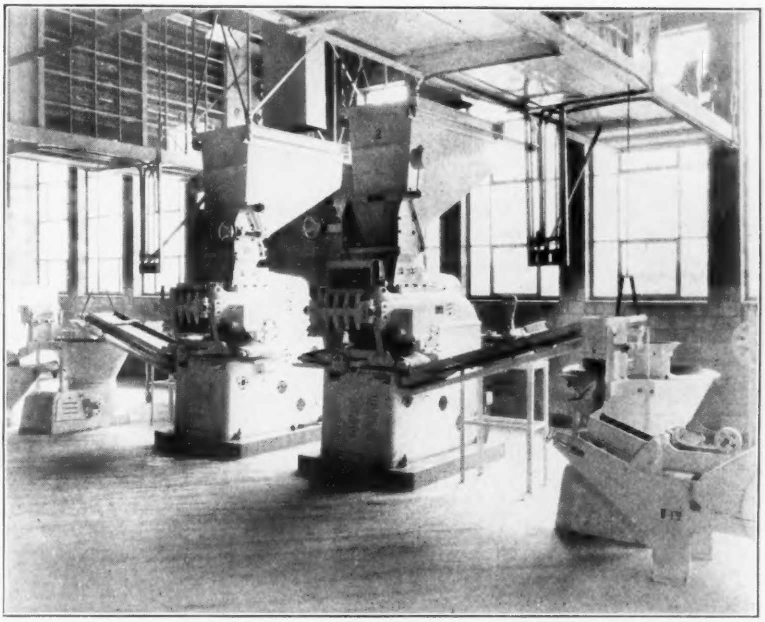


Courtesy of American Machine & Foundry Company
Fig. 2—End view of a Super "New Era" Mixer, showing manner of driving and respective location of driving elements.

portion being carried by gravity and suction into what is known as the cut-off box. Here, enclosed on all sides, it is carried forward by a reciprocating piston to fill each of the rotating

cylinder pockets with the desired quantity. The cylinder then automatically makes half a revolution, the dough in the pockets being cut cleanly from the mass contained in the cut-off box, and delivered to the working table or to suitable conveying apparatus for transmission to the rounder.

In another type, the dough is carried from the hopper by a pair of adjustable rollers to a feeding chamber which contains a reciprocating feeder. The dough is then pushed into a cylindrical plunger chamber at one side of the feed chamber by a cutter plate, and severed from the mass in the hopper. A plunger carries the dough forward into one or more opposed chambers in a revolving measuring head. Movable followers in the bottoms of these chambers eject the dough as measured. Desired weight of the loaves may be obtained without stopping the machine, by hand screw and worm adjustment to operate the followers exactly to the same extent. Mechanical operation of this machine is attained by gearing and suitable cam and connecting rod arrangements.



Courtesy of Baker Perkins Co., Inc.

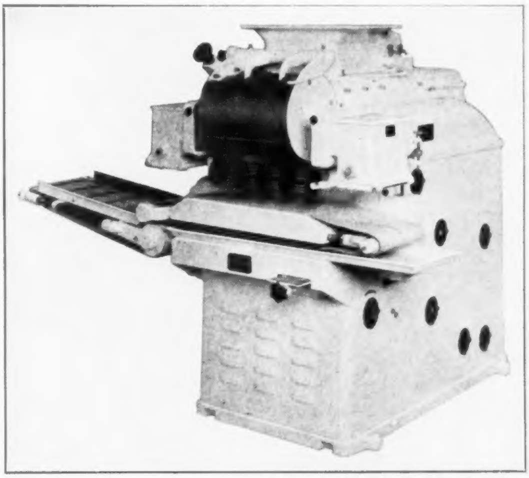
Fig. 3—Interior of a Modern Bakery showing respective location of Rounders, Dividers and Proofers.

Electric power is largely used for divider operation, the various types of dividers today requiring from one to three h.p. depending on their weight and capacity. Measuring devices may contain from one to six pockets, with a capacity of from 1,500 to 6,000 loaves of the usual weights per hour. Whatever the type of machine, there should be no inaccessible crevices to retain dough till it becomes mouldy, or greases till they become rancid.

The Rounder

The rounder subjects the dough from the divider to a number of distinct operations, simulating the action of the hands in rounding each individual piece and preventing the escape of gas from the cut ends. Rounding is done in flour or in the presence of air currents to dry the surface and cause the formation of a protecting skin. The development of the rounder came as a logical sequence to the divider, for, after dividing the dough automatically, it was essential to have a machine that would quite as rapidly round or ball up the pieces and at the same time coat them with the required covering.

The modern rounder accomplishes its purpose by the use of a kneading drum which rolls the pieces of dough around a conical shaped surface, or by the combination of a revolving conical table and spiral trough. In this way the pieces as received from the divider are rolled around in all directions to give them a perfectly spherical shape, and the cut ends completely balled up, with the necessity for little or no dusting with flour prior to subsequent handling. Average operation will handle from 2,500 to 3,500 pieces of dough per hour on an up-to-date



Courtesy of Baker Perkins Co., Inc.

Fig. 4—A Baker Perkins Divider, showing operating mechanism. Pressure lubrication is extensively used on this machine to insure against contamination of dough.

machine, with a power consumption of about one horse power.

In conjunction with the rounder a suitable flour duster may be installed with a regulator and delivery chute to control the rate at which the flour is used. A "flour catch" is also necessary to prevent dusting flour from falling to the floor. The average modern rounder will accommodate loaves and even rolls or buns of varying size with little adjustment.

Courtesy of Baker Perkins Co., Inc.
Fig. 5—Showing a Baker Perkins Rounder. By accurate control of pressures and speeds, the same effects of hand action in handling the dough is accomplished.

The Proofer

The "rest" period to which the dough must be subjected after it has left the rounder, is attained by passage through the proofer prior to delivery to the moulder. This treatment is commonly known as the preliminary proof. It may take from 8 to 15 minutes according to the type of dough. For this purpose there are various types of machines on the market, involving automatic bucket or belt conveyors, rotary motion, or simply stationary trays. The loaves are carried backward and forward by the conveying mechanism at such a speed that each will remain in the proofer the desired length of time, being then delivered by chute and hopper to the moulder.

In connection with the automatic bucket or belt proofer, a spacer is commonly used to deliver each loaf as received from the rounder to an individual container in the proofer. The spacer is simply a rotating compartment wheel, operating in connection with an incline built with drop bottom sections. These are set to open in sequence and deliver each contained loaf to a corresponding chamber on the travelling proofer conveyor.

Pan-Proofing

Dough must be subjected to a second period of proofing in the baking pans after it leaves the moulder. To the layman this is known as the "rising" period. Pan-proofers (or steam chests as they are sometimes termed) are essentially wood or metal compartments, with shelves or conveyors installed for holding the pans, or built so that wheeled shelf carriers may be rolled in bodily. In pan-proofing the temperature is important. It must be maintained constant and the degree of humidity definitely controlled; otherwise the bread will crust abnormally or be inferior in appearance and texture. Ninety degrees Fahrenheit is considered as the proper temperature, with just enough humidity to prevent crusting. Under such conditions the desired proof is obtained in from 35 to 45 minutes. Heat and humidity are maintained by an air conditioning apparatus.

The Moulder

The process by which the loaf is given its final treatment and shaping prior to baking is performed by the moulder. It is generally conceded that this machine is the greatest moneysaver in the trade, and a most important piece of mechanism. By its use each piece is subjected to the same handling to give uniform shape and texture, the kneading pressure is uniform, and exactly proportioned to the delicacy of the substance handled.

Courtesy of Thomson Machine Company
Fig. 6—Showing a Thomson Model O Moulder. Bearings of this machine are of special bronze, grooved for grease lubrication. All parts are enclosed to protect lubrication and prevent escape of lubricant. The gears which drive the drum operate in a bath of oil.

Each loaf, as it comes from the proofer, passes

into a feed hopper, being led to a series of rolls which flatten it, cause the escape of part of the gases and evenly distribute the remainder. This sheet of dough is then coiled in a spiral shape to whiten and aerate it, and also produce a uniform close grain. The coil then passes to a drum where it is kneaded and rolled, and a thin skin formed over the entire surface prior to discharge. Each piece of dough is in continuous motion throughout the machine, and there is no opportunity, in a modern moulder, for mangling or contact of any one piece with another.

Moulders will vary extensively in construction, depending on the size of loaves or output required. Principles of operation, however, are alike in all. They possess many advantages over hand moulding. For example, a mechanical moulder will enable far greater unit output, delivering with exact uniformity as high as 3,600 loaves per hour. Hand operation will average from 350 to 500 loaves per hour.

The amount of dusting flour used is greatly reduced, or even rendered unnecessary in some machines. Working conditions are, therefore, far more healthful, for fine dust in the air is largely eliminated.

One does not need to worry as to whether the baker's hands were clean.

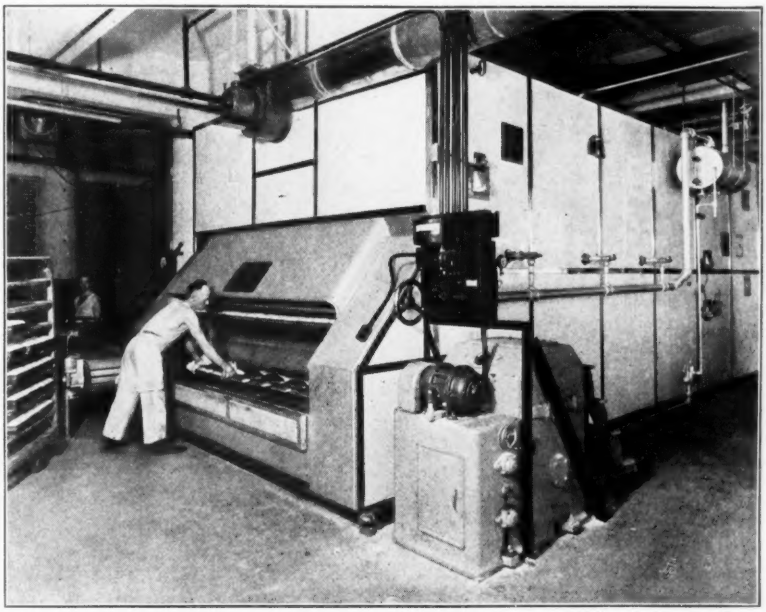
Loaves are more uniform in size, and better shaped; and possibility of discoloration in the crumb or top crust on account of excess dusting flour is eliminated.

Manual labor is reduced, hence the energy of the baker is conserved and he is able to use his best efforts in the operation of the machines to speed up output to a maximum.

The Oven

The oven is the basic element in the manufacture of bakery products. In the development of the industry, however, the oven has frequently received but scant attention, in fact, there are still in use today, in remote localities, typical relics which differ very little from the old Roman types discovered in the ruins of Pompeii. This may be explained by the fact that the baking industry has developed chiefly from a labor saving point of view. The divider, rounder, moulder and accessory handling equipment were all invented to speed up production.

As a natural consequence, the old ideas in oven construction and operation had to be superseded, though this did not occur till comparatively recently. Batch baking could no longer keep up with improved preliminary operations; nor could dough that had been scientifically and accurately prepared be depended upon to maintain its weight and consistency, or receive the same extent of baking in crude hand-fired ovens. Hence the development of the modern automatic oven. Many variations were tried out, some of which have received marked attention due to their being suited for certain classes of work. Of these the revolving oven is a typical example, as being admirably suited for the smaller bakery, though it does still involve the principle of baking by batches. For continuous operation, however, the automatic travelling oven is generally acknowledged to be the most efficient machine of its type in service today.



Courtesy of Baker Perkins Co., Inc.

Fig. 7—Driving end view of a Baker Perkins Diathermatic Double Lap, Oil Fired, Traveling Tray Oven. Note enclosed nature of all moving parts.

In general operation the loaves are fed in at one end onto an endless conveyor and carried at a slow, uniform rate of speed through the baking chamber. Rate of conveyor travel is such that, during this period, the loaves are completely baked, being discharged automatically from the opposite end of the oven. The first loaf in is naturally the first out; there-

fore, all remain in the oven practically the same length of time. Normally about 28 minutes is required to bake a one pound loaf, while 35 minutes is necessary for a pound and a half loaf. On the other hand, baking time can be definitely regulated from 15 minutes to 75 minutes by suitable variable speed transmission devices. Temperature at the beginning of baking is about 390 degrees Fahr., being controlled to rise gradually to about 450 degrees Fahr., in the center of the oven, dropping from then on back to 390 degrees Fahr., at the discharge end. Temperature control is accurately maintained and measured periodically by pyrometers at regular intervals along the oven. Speed of conveyor travel can be instantly regulated as desired to suit requirements.

Heat may be supplied from furnaces located above or below the oven. Indirect heating is generally practiced in order to keep the oven room as free from dust and dirt as possible. The principle of hot air heating is used, suitable dampers being installed to regulate "top" and "bottom" heats as necessary. Due to the customary solidity in construction the traveling oven is very economical in fuel consumed.

Slicing and Wrapping Machinery

Slicing and wrapping are comparatively recent refinements which have been adopted by the baking industry; slicing as a matter of convenience for the consumer, wrapping to conform to modern advances in sanitation and public health. Modern practice combines the operations of slicing and wrapping in one machine with provision for moving the slicing unit out of operating position when it is desired to wrap whole loaves.

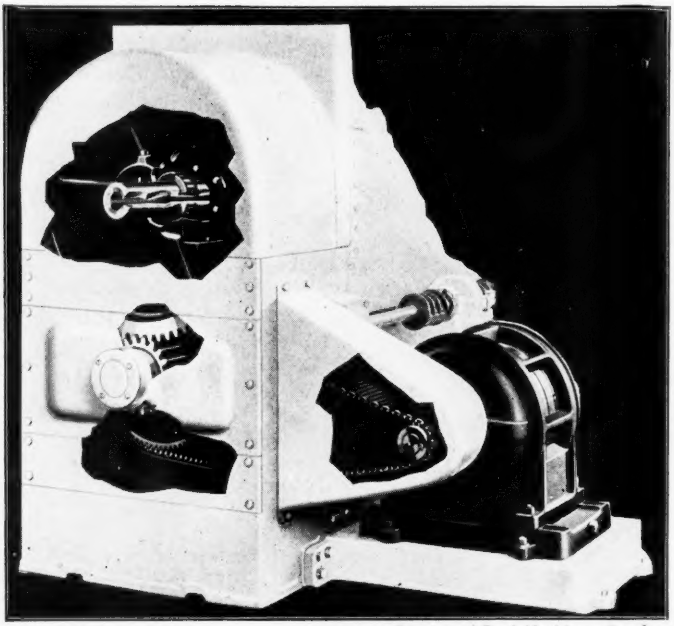
Slicing requires an installation of adjustable knives so arranged as to cut slices of uniform thickness. They function by virtue of a cam or eccentric mechanism, being held in rigid position by guides.

The wrapping machine is operated by an ingenious arrangement of cams, reciprocating motion, chain and sprocket mechanisms and carrier belts. The modern bread wrapper has been perfected to receive, wrap, seal and deliver as high as 3,400 loaves per hour with no handling. Only sufficient manual labor is necessary to regulate feed and discharge at the desired rate, and lubricate the machine parts as required.

LUBRICATION

Mixer Requirements

Lubrication of the mixer will depend on constructional details and the means provided by the manufacturers. The larger machines are practically all equipped with gear or silent chain drives, using electric power. Comparatively tight housings are used as a safety factor, to insure cleanliness and prevent dust-contamination of lubricants. Gearing is best lubricated by a pure petroleum product of a viscosity around 1000 seconds Saybolt at 210 degrees Fahr. It must possess excellent adhesive properties and not drip or be thrown off by centrifugal force. Hot application of this lubricant by means of a brush is most practicable.



Courtesy of Read Machinery Co., Inc.

Fig. 8—Cut-away view of the Read Ekco High-Speed Mixer showing driving elements and main bearing construction. All bearings are lubricated by pressure.

Driving chains can be efficiently lubricated by use of a similar product of lighter body, having a viscosity of about 200 seconds Saybolt at 210 degrees Fahr. In many cases, however, operators prefer to use a medium engine oil of 300 seconds viscosity at 100 degrees Fahr., feeding by means of a sight feed oil cup.

Bearings may be equipped with ring or chain oilers or means for pressure grease lubrication. The ring or chain oiler is positive in action and requires refilling of the reservoir only about every week or two, with complete cleaning about every three months. Its operation can always be observed from the top bearing oil hole, and maximum economy in oil consump-

tion is obtained. In the mixer these bearings are subject to high pressure and require a fairly heavy, straight mineral oil of from 300 to 500 seconds Saybolt viscosity at 100 degrees Fahr. A suitable stuffing box arrangement on the mixing arm shaft will prevent any possibility of oil entering through the main bearing to contaminate the dough.

When provisions are made for grease lubrication by means of compression grease cups or pressure gun, a carefully prepared medium consistency product will meet requirements.

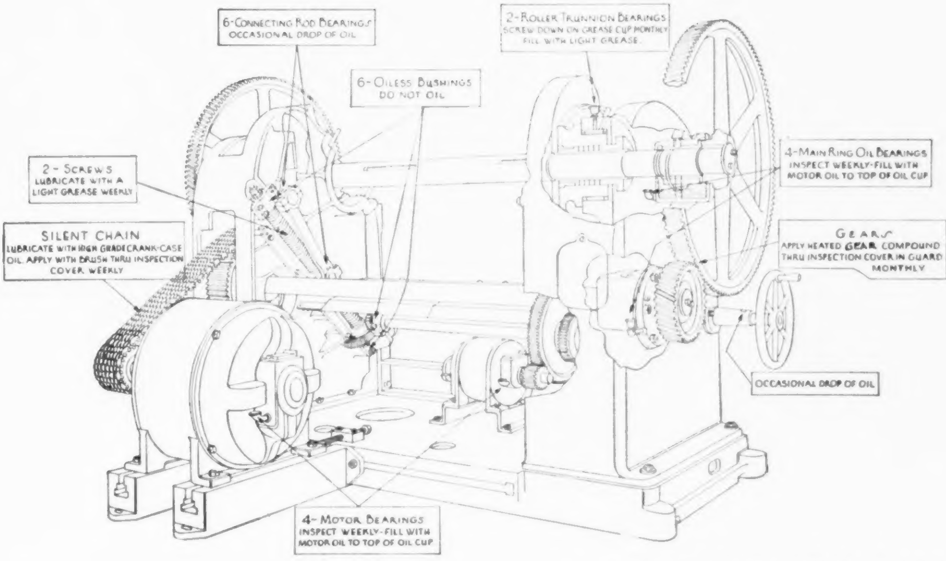
Motor bearings may be of either the ring oiled variety or equipped with ball or roller elements. Ring oilers can be served with an oil such as mentioned above or of slightly lower viscosity. Ball or roller bearings, however, require careful study of bearing design and selection of a grease capable of maintaining lubrication, preventing corrosion, and remaining within the bearing elements. This latter is of particular importance, for leakage into the motor windings might lead to accumulation of dust and necessity for complete motor overhaul.

Dividers

The modern divider is probably the most difficult machine to lubricate in the baking industry. Involving as it does the first handling of the finished dough, utmost care must be taken to prevent oil or grease from coming in contact with the product. Over-lubrication must therefore be guarded against. On the other hand, considerable power losses may result from too little lubrication.

On all parts of the cutting mechanism, such as the knife edge, plungers and back of the division box, where there is possibility of the dough coming in actual contact with the lubricant, only the highest grades should be used, such as lard, cottonseed oil, lard compound or petrolatum, or a tasteless, colorless, pure mineral oil. No oil should be selected that has a tendency to turn rancid, gum, or react with sugar to affect the taste of the bread. For this reason petrolatum or a tasteless, pure mineral oil is preferred by many operators.

General machine bearings, which are usually of sleeve design with the exception of the motor bearings, can be well lubricated by an engine oil of from 180 to 300 seconds Saybolt viscosity at 100 degrees Fahr. Electric motors, however, especially where equipped with antifriction bearings, are usually grease lubricated. Gears, chains or cam surfaces require a heavier straight petroleum lubricant, having a viscosity of about 1000 seconds Saybolt at 210 degrees Fahr. Sparing application of any such product is essential to prevent possibility of throwing, and contamination of the dough.



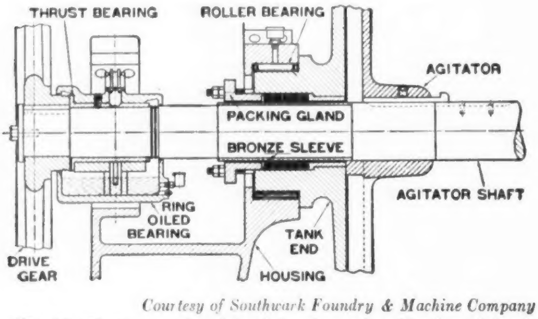
Courtesy of Southwark Foundry & Machine Company

Fig. 9—Points requiring lubrication on a Benjamin Franklin Dough Mixing and Kneading Machine. All parts, with respective suggestions, are clearly indicated.

Rounder Requirements

Rounder lubrication involves motor bearings, reduction gears, and spindle bearings. The first two points have been discussed under mixers, with suggestions as to suitable lubri-

cants. Where worm reduction gearing is used, operating the gears in a bath of oil is generally best practice, using a highly refined compounded steam cylinder oil. Concerning spindle and other bearings, where they are of the ball or roller type, a highly refined grease, such as sug-



Courtesy of Southwark Foundry & Machine Company

Fig. 10—Showing section through bearing and stuffing box of dough mixing machine (See Figure No. 9). Note manner of packing gland construction and method of lubrication, in the interest of preventing entry of lubricant into the mixer itself.

gested for electric motors, should be used. On other bearings of the sleeve type the use of a straight mineral machine oil of from 180 to 300 seconds Saybolt viscosity at 100 degrees Fahr., applied by sight feed oil cups, will be suitable. Certain smaller sleeve bearings may require lubrication by means of pressure gun or grease cups; on these, a medium consistency compression cup grease will assure of adequate protection.

Proofer Lubrication

The modern automatic proofer involves no particular lubrication problem, for inasmuch as the conveyor rolls are often equipped with wooden bearings, only the motor bearings, the metallic bearings of the spacer, the main driving mechanism, and reduction gears require lubrication.

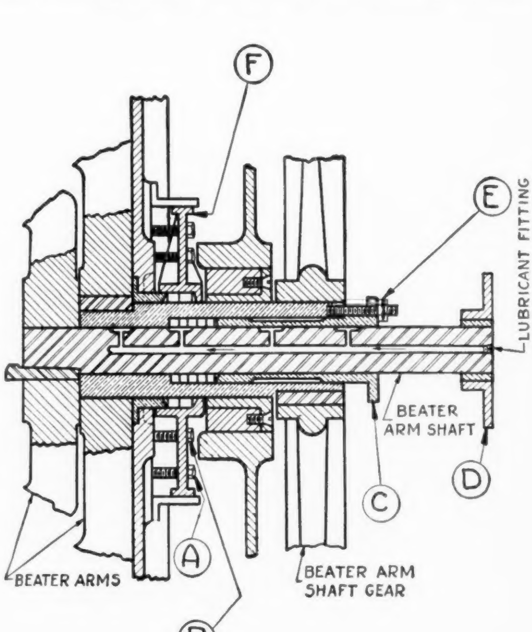
Motor bearings and gears have already been discussed. The other bearings are usually designed for grease lubrication. In such service a light-bodied compression cup grease is suitable. Certain types of automatic proofers, including those of the revolving shelf type, are equipped with roller or ball bearings on the main and auxiliary driving shafts. Lubrication, in such instances, is best attained by use of a specially prepared, medium consistency grease. Over-lubrication of any such bearing must, of course, be prevented, otherwise drag and increase in power consumption and bearing temperature might result.

The Moulder

The manner of drive is of interest in a discussion of moulder lubrication. In general, motor drive to the rolls, via silent chains or belts, using a suitable speed reduction mechanism is the most common construction in such apparatus. Gear and chain lubrication has been discussed heretofore under Dividers and Mixers. Bearing lubrication is largely a matter of greasing, the parts being so designed as to present little or no possibility of the lubricant contaminating the dough. It is common practice on bearings of this type to install grease cups or pressure grease fittings, since they are relatively small and are usually not built with automatic oiling devices such as rings or chains. For all such bearings a light-bodied compression cup grease is most suitable.

Oven Conditions

Lubrication is an important detail in oven operation; it is, in effect, one of the outstanding factors which will assure of dependable service. Obviously, shutting down of the oven would absolutely terminate production over the period of shut-down. The rigid construction of the driving mechanism for the conveyor and



Courtesy of American Machine & Foundry Company

Fig. 11—Details of construction of beater arm shaft and packing glands of Super "New Era" Dough Mixer. Lubrication is effected through a pressure fitting as indicated. Path of lubricant through interior of beater arm shaft is shown by arrows. There are four points of lubricant outlet from this channel. Shaft bearing is equipped with spiral grooves over each outlet to enable proper distribution of grease.

the component parts of this latter is often deceiving, yet they all require quite as much attention from a lubricating viewpoint as any other machinery in the bakery. In operation, conveyor chain links, rollers, bushings and rods are subjected to most exacting service and

normally are expected to run for indefinite periods without extensive repair.

Lubrication of such parts may become quite a problem, for the usual grades of machine oils will not stand up for any length of time under the temperatures involved. As a result, there is a tendency of some operators to give the matter up as a hopeless job, and neglect lubricating such parts entirely. It is practicable, however, to obtain lubricants of special refinement for this service. All wearing parts exposed to oven temperatures, for example, can be lubricated with a relatively light application of heavy mineral oil of low carbon residue content that will not undergo sufficient reduction in viscosity to drip or flow from the wearing parts. Many engineers, on the other hand, prefer to use a mixture of graphite and light mineral oil. The latter will naturally evaporate rapidly, but the graphitic residue is claimed to work its way into the rolls quite effectively to insure proper lubrication. Still others have found specially refined high melting point greases to be satisfactory.

The conveyor driving mechanism, in turn, involves a problem of gear and bearing lubrication, especially where gearing is exposed and operated at relatively slow speeds. For this purpose a straight mineral gear oil of about 2000 seconds Saybolt viscosity at 210 degrees Fahr., furnishes an excellent and most durable film of lubricant, which is resistant to dripping or throwing. Bearings for gear shafts and conveyor sprockets may be of the ring or chain oiled type, or else of simple split bearing construction equipped with sight feed oil cups. In either case a medium bodied engine oil of from 300 to 500 seconds Saybolt viscosity at 100 degrees Fahr., will meet the requirements. Where oil cups are used careful and periodic application is necessary.

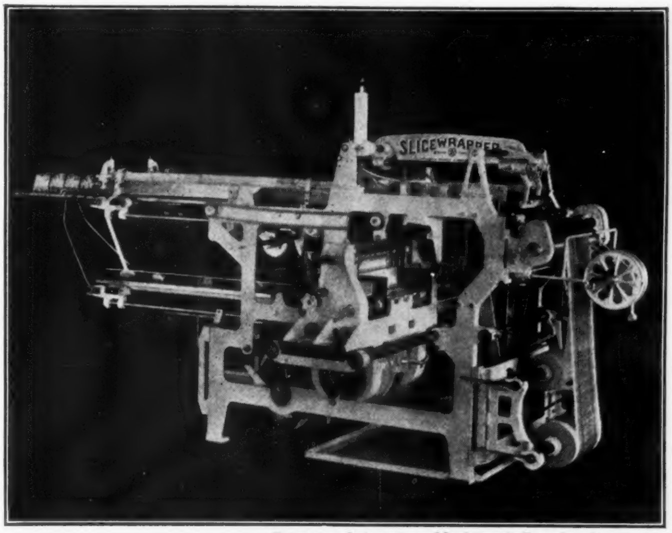
In the rotary or revolving type of automatic oven involving worm gear drives a highly refined, compounded steam cylinder oil will be satisfactory. Other parts of such ovens requiring lubrication should be studied as to construction and means of application. Normally, the products mentioned heretofore will serve the purpose satisfactorily.

Slicing and Wrapping Machinery

Lubrication of this equipment presents no particular lubricating problem. As usually designed, slicing and wrapping machines are constructed for oil cup or pressure grease lubrication. The oil to use for such service should be a relatively light bodied straight mineral product of around 200 seconds Saybolt viscosity at 100 degrees Fahr. When a grease is called for, a highly refined light to medium consistency product will serve the purpose. Whatever the means allowed for lubrication, a certain amount of care should be observed to insure against splash or dripping of excess lubricant onto the bread or wrapping paper. Pressure operated grease cups, with means for indicating their grease content, have been adopted by certain builders, with a view to insuring positive lubrication with minimum waste or leakage.

Miscellaneous Equipment.

Other machinery in the modern bakery, such as conveying apparatus for handling the loaves, and specialty machines, including cake mixers, pie crimping machines, meringue mixers, etc., involve no specific lubricating problems. As a general rule, a good light bodied compression cup grease, or medium viscosity straight mineral oil of from 200 to 300 seconds Saybolt will be suitable according to the means provided for application.



Courtesy of American Machine & Foundry Company

Fig. 12—Showing side view of AMF Slice-Wrapper. This is a bread wrapping machine with an inbuilt slicing unit. Above view shows this unit disengaged to permit machine to wrap whole loaves. Pressure lubrication is employed.

The Viscosity Test— Its Meaning And Application

The viscosity test has proved of value as a means of determining the physical ability of a lubricating oil to maintain lubrication under any set conditions of operating pressure and temperature. It is of distinct importance to have a clear understanding of this test in view of the relation of fluid or internal friction to power consumption. Obviously, reduction of fluid friction will lead to proportional reduction in power consumption.

Viscosity or body of an oil, as it is more generally understood by the average operator, is a measure of the relative fluidity at the temperature of observation. It can also be regarded as that inherent property by virtue of which flow is retarded, due to the resistance which the particles or molecules of an oil will offer to one another as they come in contact in circulation through the lubricating system or between the moving parts of a machine. It is possessed by all lubricating oils to a varying degree, according to their extent of refinement. Viscosity will vary inversely with temperature, i.e., the colder an oil the heavier or more sluggish will it become. In contrast, as the temperature is raised, the same oil will become more and more fluid.

Viscosity is measured by observing the time required for a predetermined quantity of oil, i.e., 60 cc., to flow through an orifice of standard size under standard temperature conditions. The Saybolt Universal Viscosimeter and the Saybolt Furol Viscosimeter have been adopted for this purpose by the American Society for Testing Materials.

So, for example, when an oil is spoken of as having a viscosity of 500 seconds Saybolt at 100 degrees Fahr., this means that at a uniform temperature of 100 degrees Fahr., it will take 60 cc. of the oil in question 500 seconds to flow through the viscosimeter orifice.

The Universal machine is used to determine the viscosity of light, medium or heavy lubricating oils, standard temperatures of test being 100, 130, or 210 degrees Fahr. The Furol machine is used for fuel oils or other oils of similar viscosity at standard temperatures of 77, 122, or 212 degrees Fahr. The essential difference between these machines is in the diameter of the outlet tube or orifice, the Furol tube being the larger, to accommodate flow of heavier oils. In handling such products it is about ten times faster than would be the Saybolt machine, as a result, a numerical reading by the Furol Instrument would be one tenth as great as shown by the Saybolt machine for the same oil.

In normal practice 100 degrees Fahr., is standard for the Saybolt machine when dealing with distilled or blended lubricating oils of a viscosity up to about 900 seconds. For heavier products which are to be used at higher temperatures, such as light gear lubricants, airplane engine or steam cylinder oils, 210 degrees Fahr., is preferred. The obvious advantage in raising the temperature of test with such products is to decrease the time element involved and expedite the actual procedure of testing.

Significance of Results

According to the American Society for Test-Materials*—"the significance of viscosity depends upon the purpose for which the oil is to be used.

"For lubricating oils viscosity is the most important single property. In a bearing operating properly, with a fluid film separating the surfaces, the viscosity of the oil at the operating temperature is the property which determines the bearing friction, heat generation, and the rate of flow under given conditions of load, speed and bearing design. The oil should be viscous enough to maintain a fluid film between the bearing surfaces, in spite of the pressure tending to squeeze it out. While a reasonable factor of safety is essential, excessive viscosity means unnecessary friction and heat generation. Since the rate of change of viscosity with temperature varies with different oils, viscosity tests should in general be made at that standard temperature which approximates most closely the temperature of use."

Value of the Viscosity-Temperature Chart

Wherever operating temperatures may be abnormal, prediction of the approximate viscosity at the prevailing temperatures will be of distinct aid in the selection of lubricants which will carry the prevailing loads with the minimum of power consumption. This can be accomplished by use of the A.S.T.M. viscosity-temperature chart (See Fig. 13). With such a chart it is possible to estimate the approximate operating viscosity of any particular grade of oil over a temperature range from —30 degrees Fahr., to 450 degrees Fahr., knowing the viscosity at any two points, such as 100 and 210 degrees Fahr., according to the prevailing marketing specifications.

In considering extreme temperatures, however, we must remember that viscosity values

*The Significance of Tests of Petroleum Products—Report of Committee D-2 of the A.S.T.M., July 1929—P. 11-12.

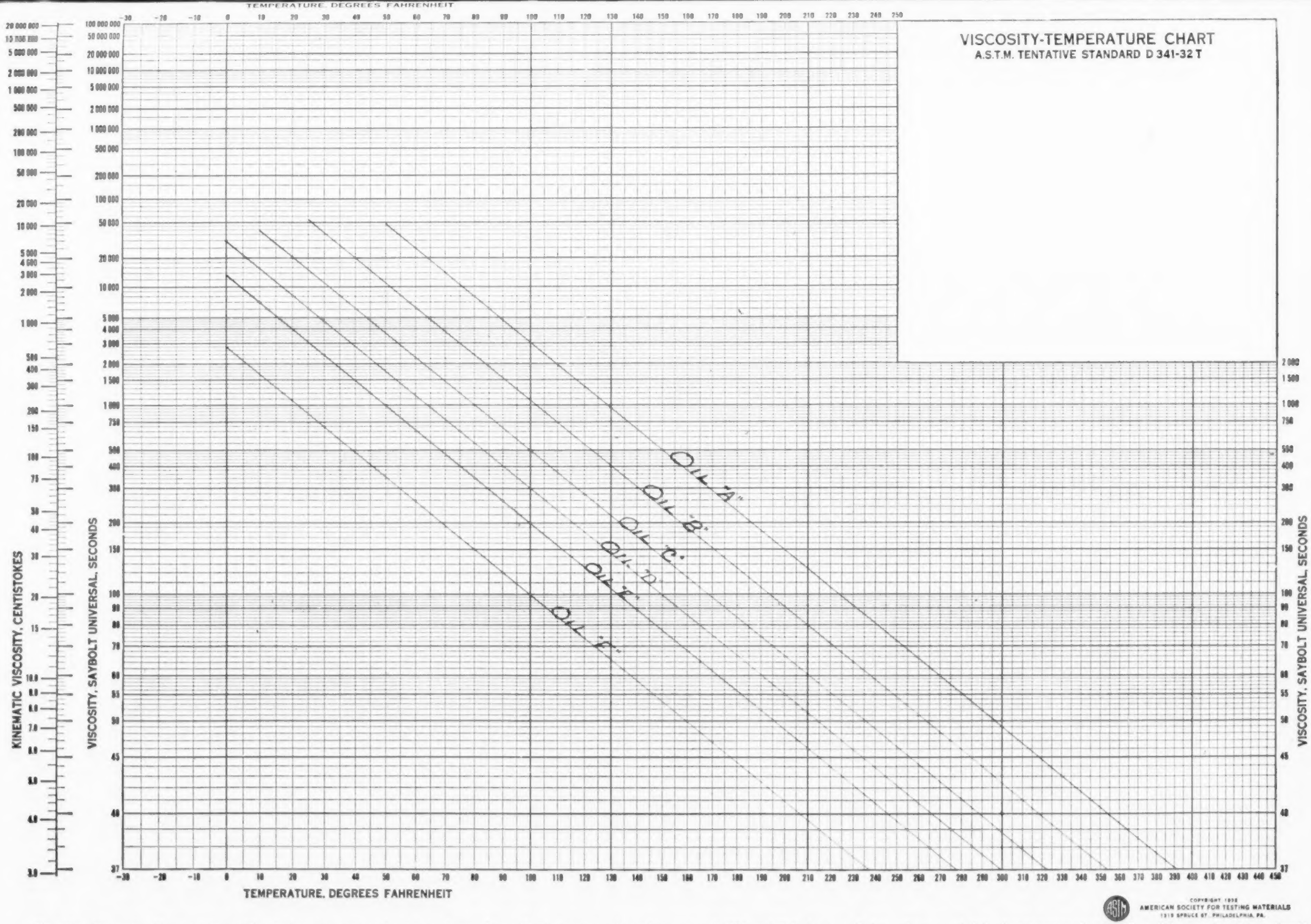


Fig. 13—Viscosity-Temperature Chart showing curves for typical wax-free oils of average viscosity range at 100 and 210 degrees Fahr. By use of this chart, approximate viscosities can be determined at other temperatures, within the limits indicated. If there were a tendency for wax crystals to form at lower temperatures, the viscosity slopes could no longer be represented by straight lines. With some oils, in which wax crystals form, there is a distinct upward trend at only a few thousand seconds viscosity. High viscosities are, of course, purely empirical as they could not be measured accurately on any apparatus generally used at present.

are more academic than practical. At —30 degrees the viscosity of all ordinary oils runs up into the tens of thousands or even millions and at this temperature most oils have other characteristics that control more than the theoretical viscosity. It must also be pointed out that, at extremely low temperatures, as can be seen by the accompanying chart, a difference of 5 degrees may lower the apparent viscosity almost 50 per cent. Along this same line of thought, but opposite in direction, when viscosities approaching 450 degrees are concerned, they mean little from a lubricating standpoint. For instance, an oil to have a viscosity of 40 seconds at 450 degrees (corresponding to that of a very light spindle oil) would have to have a viscosity at 100 degrees of tens of thousands in order to meet this requirement, which would render it impracticable for use in any ordinary machinery.

Air Compressor Practice

Use of an oil of too high a viscosity in air compressor service may lead to development of gummy matter and sticking of piston rings. It may also cause the resultant oil film on the cylinder walls to collect any dust that may be present in the air, to increase the formation of objectionable deposits within the compressor or air lines. This is especially likely to happen when more oil has been used than just sufficient to lubricate the wearing surfaces, or when an air cleaner is not used. Most effective lubrication of compressors is attained by using an oil of just sufficient viscosity to sustain the weight of the moving parts and maintain the desired seal between the piston rings and cylinder walls. It must never be too light in body, otherwise seal may be impaired at cylinder operating temperatures.

Automotive Engine Service

Knowledge of the meaning of viscosity is of particular advantage to the motorist in meeting the operating conditions of warm weather driving, for thereby can he more intelligently select an oil which will possess adequate operating viscosity to maintain protective lubrication. Obviously modern conditions of higher automotive engine temperatures require oils of higher viscosity. This will be especially true in warm weather in the interest of reducing oil consumption, when the amount of external cooling is proportionally reduced. A certain amount of oil consumption is necessary regardless of engine design or the grade of oil used. Where there is no apparent consumption, dilution is contributing toward maintenance of the oil level. It is practicable, however, to reduce consumption to a certain extent by selection of motor oil of adequate viscosity to withstand the effects of higher temperatures. In this respect modern data, however, has shown that oil consumption is more a function of the engine than of the viscosity of the oil. Most automotive engines increase consumption rapidly with speed in a far greater proportion than would be expected from the speed of the engine. Also, most engines have a critical point in respect to oil viscosity and consumption under constant speed conditions,—that is, as we increase viscosity we lower consumption to a certain point. Further increase in viscosity actually increases consumption. Under these conditions use of a more viscous oil does more harm than good, especially as such oils may cause accumulation of objectionable carbon deposits.

The Society of Automotive Engineers has made marked progress in aiding the motorist to maintain dependable lubrication by the adoption of a scheme of numbering motor oils according to certain viscosity ranges. This has definitely eliminated the use of such terms as light, medium, heavy, etc., according to the brand of oil involved and the respective opinion of the refiners as to the range of viscosity each term should cover. Due to lack of cooperation these terms used to cover an extremely wide viscosity range.

There is, however, more to the selection of motor oils than the mere idea that the term "heavy" should apply to comparatively warm weather service, and conversely the terms "medium" or "heavy medium" to low temperatures. A precise knowledge of the actual viscosity range as physically expressed is required. This, however, may be misunderstood by some.

For this reason the Society of Automotive Engineers has recently standardized upon a system of grading in the interest of a more intelligent understanding of the importance of the right viscosity for any set of engine or operating conditions. By concurrence with this system, the petroleum industry has shown its broad minded interest in cooperation, to the end that now the motorist is assured of a standardized viscosity nomenclature irrespective of his preference in regard to brand of oil or its degree of refinement.

The automotive manufacturers also have indicated their approval of this system of numbering by adopting it for the recommendation of engine lubricants in their instruction booklets.

The S.A.E. system is based upon numbers. The measured viscosity in seconds by the Saybolt Universal Viscosimeter is taken at 130 or 210 degrees Fahr., to provide a knowledge of the proper fluidity at average operating crankcase temperatures.

The reputation of the individual refiner must be depended upon in this regard as S.A.E. Numbers cannot be taken as a criterion of quality.

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